

WHAT WE CLAIM IS:

1. A catalyst for oxygen reduction comprising a ruthenium sulfide chemically stable in a hydrochloric environment in the presence of dissolved chlorine and optionally of dissolved oxygen.
2. The catalyst of claim 1 wherein said ruthenium sulfide is supported on a conductive inert support optionally consisting of carbon having a surface area exceeding 120 g/m^2 .
3. The catalyst of claim 2 wherein said carbon is Vulcan XC-72.
4. The catalyst of claim 1 wherein said sulfide is Ru_xS_y supported on carbon.
5. The catalyst of claim 4 obtained by incipient wetness impregnation of said carbon with precursor salts of ruthenium, optionally comprising ruthenium chloride, evaporating the solvent and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.
6. The catalyst of claim 4 obtained by aqueous precipitation of a ruthenium oxide on said carbon, drying and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.

7. The catalyst of claim 1 wherein said sulfide has the formula Ru_xM_yS , M being a transition metal.
8. The catalyst of claim 7 wherein said metal M is selected from the group consisting of Ni, Re, Cr, Mo and Ir.
9. The catalyst of claim 1 wherein said sulfide is Ru_xCo_yS supported on carbon.
10. The catalyst of claim 9 wherein the atomic ratio Ru:Co is comprised between 0.2 and 5.
11. The catalyst of claim 7 obtained by incipient wetness impregnation of said carbon with precursor salts, optionally chlorides, of ruthenium and of transition metal M, evaporating the solvent and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.
12. The catalyst of claim 9 obtained by incipient wetness impregnation of said carbon with precursor salts of ruthenium and of cobalt, evaporating the solvent and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.
13. The catalyst of claim 12 wherein said precursor salts comprise at least one of $RuCl_3$ and $Co(NO_3)_2$.

14. The catalyst of claim 11 wherein said solvent comprises 2-propanol.
15. The catalyst of claim 11 wherein said solvent evaporation is carried out under vacuum at a temperature above 90°C.
16. The catalyst of claim 11 wherein said treatment under an atmosphere of hydrogen sulfide is carried out in a flow reactor.
17. The catalyst of claim 11 wherein said treatment under an atmosphere of hydrogen sulfide is carried out at a temperature exceeding 100°C.
18. The catalyst of claim 11 wherein said treatment under an atmosphere of hydrogen sulfide is protracted for a time exceeding thirty minutes.
19. The catalyst of claim 11 wherein said inert carrier gas is nitrogen and the molar ratio of said nitrogen to said hydrogen sulfide is comprised between 0.5 and 4.
20. A gas diffusion electrode comprising a conductive web wherein the catalyst of claim 1 is applied on at least one face of said conductive web.
21. The gas diffusion electrode of claim 20 wherein said conductive web is a carbon cloth.

22. The gas diffusion electrode of claim 20 wherein said catalyst is mixed with an optionally perfluorinated hydrophobic binder.
23. A method for producing a catalyst for oxygen reduction comprising the steps of subjecting a conductive support to incipient wetness impregnation with a solution containing at least one precursor of ruthenium, drying the impregnated support and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.
24. The method of claim 23 wherein said solution also contains a precursor of a transition metal.
25. The method of claim 24 wherein said transition metal is selected from the group consisting of Co, Ni, Re, Cr, Mo and Ir.
26. The method of claim 25 wherein said solution contains at least one of RuCl_3 and $\text{Co}(\text{NO}_3)_2$.
27. The method of claim 26 wherein the molar ratio of Ru:Co in said solution is comprised between 0.2 and 5.
28. The method of claim 23 wherein said solution comprises 2-propanol.

29. The method of claim 23 wherein said drying is carried out under vacuum at a temperature above 90°C.
30. A method for producing a catalyst for oxygen reduction comprising the steps of precipitating a ruthenium oxide on a conductive support dispersed in an aqueous solution, drying the impregnated support and treating the resulting product under an atmosphere of hydrogen sulfide optionally diluted with an inert carrier gas.
31. The method of claim 23 wherein said treatment under an atmosphere of hydrogen sulfide is carried out in a flow reactor.
32. The method of claim 23 wherein said treatment under an atmosphere of hydrogen sulfide is carried out at a temperature exceeding 100°C.
33. The method of claim 23 wherein said treatment under an atmosphere of hydrogen sulfide is protracted for a time exceeding thirty minutes.
34. The method of claim 23 wherein said inert carrier gas is nitrogen and the molar ratio of said nitrogen to said hydrogen sulfide is between 0.5 and 4.

35. The method of claim 30 wherein said ruthenium oxide is RuO_2 precipitated by reacting an aqueous solution containing a ruthenium compound, optionally RuCl_3 , with sodium acid carbonate, or by reacting ruthenium sulfite acid with hydrogen peroxide.
36. A method for producing a gas diffusion electrode of claim 20 comprising coating said conductive web on at least one side thereof with said catalyst optionally mixed with a first hydrophobic binder.
37. The method of claim 36 wherein said conductive web is a carbon cloth.
38. The method of claim 36 wherein said first hydrophobic binder is perfluorinated.
39. The method of claim 36 wherein said conductive web is coated with a mixture of carbon powder and a second optionally perfluorinated hydrophobic binder on at least one side thereof, prior to said coating with said catalyst.
40. The method of claim 36 further comprising a final sintering step.
41. The method of claim 40 wherein said final sintering step comprises heating under a hydrogen atmosphere from room temperature up to an intermediate temperature, and subsequently heating under an inert atmosphere from said intermediate temperature up to a final temperature.

42. The method of claim 41 wherein said intermediate temperature is between 100 and 120°C.

43. The method of claim 41 wherein said final temperature is between 300 and 350°C.

44. The method of claim 41 wherein said inert atmosphere is an argon atmosphere.

45. In a depolarized hydrochloric acid electrolysis cell, the improvement comprising using an oxygenated gas diffusion cathode of claim 20.